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ASSESSING INNOVATIONS IN INTERNATIONAL RESEARCH AND DEVELOPMENT PRACTICE

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Abstract
Enhancing impacts of international development interventions has become a central issue of the twenty-first century. Conventional monitoring and evaluation (M&E) tools either focus on efficiency (output-to-input relationships) or strive to demonstrate a logical progression from specific actors and factors of an intervention to development impacts (inputs => activities => outputs => outcomes => impacts). However, in complex adaptive systems there is neither such a linear results chain nor can impacts be unambiguously attributed to an actor or a factor. Therefore, alternative ways of doing M&E focus on outcomes — the changes in behaviour and social relations — rather than on impacts, such as poverty reduction, environmental protection and social inclusion. Innovation systems thinking, particularly in renewable natural resource, agriculture and rural development, informs that the dominant paradigm of impact assessment should be complemented by social innovation assessment, providing research and development actors with critical learning lessons. This paper integrates two distant bodies of literature — the literature on impact assessment of research and development interventions, and the literature on social psychology of assessing learning and innovations. Based on case studies of a series of projects implemented in India and Nepal under DFID's 11-year Renewable Natural Resources Research Strategy (RNRRS) programme between 1995 and 2006, a social innovation assessment tool was developed and implemented. The tool includes questions about critical incidents and modes of stakeholder interactions to be ranked on a four-point scale depending on how often the statements apply to the respondents' work environments. The social innovation assessment provides critical learning lessons for social innovation generation and overall performance improvement in collaborative research and development interventions at the organisational, network and system levels.

Key Words: Agriculture, Systems of Innovation, Social Innovation, India, Nepal, South Asia

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1. INTRODUCTION

Assessing impacts of research and development interventions is an ongoing challenge as is enhancing and demonstrating impacts. Poor impacts of project and programme interventions can be due to either poor implementation or failure to demonstrate impacts of otherwise successful interventions — mainly due to a mismatch between assessment methods and the nature of interventions. Innovation systems theorists, particularly in the fields of renewable natural resources, agriculture and rural development, argue that the dominant paradigm of economic impact assessment faces challenges in providing critical institutional learning lessons on ways to improve research, development and innovation processes (Hall et al. 2003). Although the innovation systems approach has appeared as a holistic learning-based framework, current methodology to assess learning and innovation performance is still rudimentary, specifically when secondary data is not available. An appropriate research approach in such a new field of study is through exploratory case studies (Eisenhardt 1989; Yin 2002). However, the importance of case study research methods to complement the dominant paradigm of impact assessment is questionable until their analytical strength — and relevance to public policy and poverty reduction — is improved, going well beyond the contemporary focus on exploratory case studies (Spielman 2005).

Recognising the limitation of an exploratory case study technique to complement the dominant paradigm of impact assessment, this study integrates case study research and survey research methods consecutively in order to assess stakeholder interactions for learning and innovation. To provide a natural progression from the former to the latter, a third research method, the critical incident technique, was embedded within the case study. This was possible because case study research and critical incident technique are flexible methods and share common data collection procedures, such as individual interviews, group interviews, direct observation and document analysis (Butterfield et al. 2005; Flanagan 1954; Yin 2002). Based on the findings of the case study and critical incident technique, a social innovation assessment (SIA) tool was designed and implemented in the Chitwan district of Nepal and Krishna district in the south Indian

state of Andhra Pradesh. The entry points of these studies involved a series of projects under the Plant Science Programme in Nepal and the Crop Post-Harvest Programme in India implemented under DFID's 11 year Renewable Natural Resources Research Strategy (RNRRS) programme, which took place between 1995 and 2006 before its most recent incarnation into the Research into Use Programme (RIU).

This discussion paper investigates whether and how various mainstream and alternative M&E techniques and tools relate with social innovation assessment, and how the latter provides institutional learning and insights into subsequent behavioural changes of research managers, development workers and intended beneficiaries. A two-stage social innovation assessment framework is developed and tested, emphasising its direct use in enhancing learning and innovation, and indirect use in public policy processes.

2. PARADIGMS OF PERFORMANCE ASSESSMENT

There are assessment approaches that focus either on outputs or on impacts only. Two points must be noted here; *first*, the input-output causal analysis of economic impact assessment, such as cost-benefit analysis and internal rate of return, considers outputs — such as patents or publications — as the intermediate indicators of innovation. Such assessments that focus only on outputs have limited explanatory power as they consider innovation to be a linear process driven by the supply of scientific research and technology development. As a result, various systems approaches — innovation systems thinking being one of the latest derivatives of systems thinking — have emerged since the second half of the twentieth century (Hall, Mytelka and Oyeyinka 2006). *Second*, the Logical Framework Approach (LFA or logframe) focuses on impacts well beyond the spheres of influence of specific project interventions with a risk of attribution error. Since impacts result from interactions among a number of actors and factors in complex adaptive systems, attribution of impacts to an individual agent or a single intervention provides a challenge for effective performance assessment. This section reviews literature on how stakeholders benefit from addressing their respective contributions towards development outcomes and impacts rather than competing for attribution.

Actor and Factor Attribution

When dealing with complex adaptive systems, such as innovation systems in renewable natural resources, agriculture and rural development, the diverse number and types of actors can make it practically impossible to attribute impacts to an individual actor. For example, as one proceeds from scientific research, knowledge and technology development, knowledge application and ultimate impacts on achieving social goals, the number and type of actors involved in the process become too large for any successful measure of the impacts of research (Springer-Heinzea et al. 2003). Scholars also agree that it is impossible to demonstrate a causal link between the presentation of research results as outputs, and policy decisions as outcomes, and their subsequent implementation and impacts on social goals, such as economic growth, environmental

protection and poverty reduction (Gijsbers et al. 2001; Pestieau 2003). This challenge has become more apparent in participatory research and technology development as different stakeholder groups, including researchers, development activists, extension agents, policy makers, irrigation engineers, farmers, input suppliers, and market agents, may all claim that the lion's share of positive impacts resulted from their activities (Lilja and Dixon 2008; Springer-Heinzea et al. 2003). Such a challenge was evident from DFID's Plant Science Programme that was implemented over several years through the involvement of multiple stakeholders and reported as one of the best bets (Stirling, Harris and Witcombe 2006).

Recognising the problem of attribution, particularly in complex adaptive systems, impact assessment should focus, instead, on the analysis of the contribution of multiple stakeholders at organizational, inter-organisational, network and system levels. The relevant parameters to study involve the rules for generating, collecting and sharing information, financing procedures, intellectual property rights, regulations and availability of human and financial resources (Ekboir 2003). New actors in the system must also be exposed to the role of local, national and international media (Hambly Odame 2003). Networking and linkages are becoming more important for social innovations, and attributing impacts to an individual actor within complex evolving networks of actors can easily be problematic (Horton et al. 2003).

Apart from actors, there are a multitude of factors that can influence the impacts of research and development interventions. Impact assessors, therefore, must document a much broader range of factors contributing to two or more impacts (Lilja and Dixon 2008). Agricultural development, for instance, is influenced by many factors, including technology, information, policies, markets, infrastructure and weather, and should contribute to diverse long-term goals, such as poverty reduction, social inclusion and environmental protection (Springer-Heinzea et al. 2003). Because many factors influence systems performance — evolutionary and path-dependent nature of technology, frequency and mode of interaction among diverse types of actors, and external environment, market and non-market institutions, etc.,— impact assessment should be

conducted from a systems perspective (EIARD 2003; Ekboir 2003; Nelson 1987; Nelson and Winter 1982; Springer-Heinzea et al. 2003).

The problem of an attribution gap is compounded by the evolutionary nature of technological and institutional change because impacts are often a result of a number of actors and factors and may appear many years after an intervention is completed (Douthwaite et al. 2003; Kuby 1999). Therefore, assessing impacts as a logical progression of outcomes (inputs => activities => outputs => outcomes => impacts) that have been strived for in the process of logframe-based planning, monitoring and evaluation is arguably flawed as far as a particular intervention is concerned. To this end, the Outcome Mapping technique developed at the International Development Research Centre (IDRC) of Canada documents the ways various actors and factors contribute to outcomes, such as changes in behaviour and relationships, rather than trying to attribute a particular outcome or impact to a single actor, factor or intervention (Earl, Carden and Smutylo 2001; Smutylo 2001).

Towards Alternative Analytical and Methodological Techniques

Scholars are well aware that impact assessments and other kinds of evaluations are not utilised effectively either in the policy process or in institutional learning lessons. There can be four intended uses of evaluation results — for direct use in operational decision-making, for indirect use in the policy process, for symbolic use to demonstrate accountability and for process use to bring behavioural and cognitive change through the participation of managers, scientists and other stakeholders in the evaluation process (Horton et al. 2003; Mackay and Horton 2003).

According to scholars, the international development community may be interested in the direct use of evaluation results in policy processes where their indirect use may be more appropriate and their indirect use in operational decisionmaking where direct use is more appropriate (Mackay and Horton 2003). In other words, evaluation results are just one

source of information in the policy process and can be a meaningful source of information for operational decisions and change management.

Scholars have moved beyond conventional territories of impact assessment to foster learning and change adapting alternative methods, such as outcome mapping (Armstrong et al. 2000; Earl, Carden and Smutylo 2001; Smutylo 2001), impact pathway analysis (Douthwaite et al. 2003; Springer-Heinzea et al. 2003), results-based management (Kusek and Rist 2004; Pestieau 2003), innovation histories (Biggs 2008; Hovland 2007; Watts et al. 2008), appreciative inquiry (Biggs 2008; Guijt 2007; Hovland 2007; Ochieng 2007; Watts et al. 2008), social network analysis (Brock 1999; Hovland 2007; Krishna and Shrader 1999; Scott 2000; Watts et al. 2008; White 2002), most significant change (Guijt 2007; Hovland 2007; Watts et al. 2008), listening narratives (Guijt 2007), and episode analysis (Hall, Sulaiman and Bezkorowajnyj 2008a; Hovland 2007; Leksmono et al. 2006).

Explanations of some of the above impact assessment and evolution methods illustrate how scholars have moved from economic impact assessment to institutional learning lessons. Here three relatively common methods are considered for illustrate purposes.

i. **Outcome Mapping**: While recognising the results paths (inputs => activities => outputs => outcomes => impacts), outcome mapping considers outcomes as behavioural change — change in knowledge, attitude, skills and actions (Armstrong et al. 2000; Earl, Carden and Smutylo 2001; Smutylo 2001). The reason for viewing outcomes as changes in behaviour and human relations is to stress that development's primary concern to improve the way people behave towards each other and with the environment. Although outcome mapping does not rule out the logical link of outcomes to long-term sustainable development goals — economic growth, social inclusion and environmental protection — it is well recognised that these long-term goals are influenced by unexpected and/or uncontrollable factors. Such an influence can result in unintended positive and negative consequences of well-meaning interventions (Axinn 1988; Merton 1936),

but stakeholders would be tempted to report only positive consequences (Pant and Hambly Odame 2009). Therefore, outcome mapping intentionally limits planning, monitoring and evaluation of results to outcomes, which are within the sphere of influence of an organization or a particular intervention, and to the strategies it uses to work towards achieving those outcomes (Smutylo 2001).

ii. **Impact Pathway Analysis**: Impact assessment scholars at the German Agency for Technical Cooperation (GTZ) propose a two-stage impact assessment approach called impact pathway analysis (Douthwaite et al. 2003; Springer-Heinzea et al. 2003). In the first stage, an intervention is expected to create results paths to see how the intervention aims to achieve results. Then the result paths or impact pathways are used to guide interventions in complex systems. The impact pathway may evolve over time based on learning and critical reflections. In the second stage, an *ex post* assessment of benefits of interventions are done to establish links between the project outputs and development impacts, such as poverty alleviation. Since the design of an impact pathway is kept open for revision, and is expected to evolve over time, it can accommodate the socially constructed views of different stakeholders incorporating information from a variety of sources and methods and repeating this process as needed (Springer-Heinzea et al. 2003). In an effort to link implementation of activities with long-terms results (outcomes=>impacts), impact pathway analysis recognises that the implementation (inputs =>outputs) is internal to a project or programme, and is often under its control. However, the other processes (outputs=>outcomes=>impacts) are external to an intervention (Springer-Heinzea et al. 2003).

iii. **Results-Based Management**: With increasing demand for accountability, public and private sector organisations have increasingly adopted results-based management (Kusek and Rist 2004; Pestieau 2003). Results-based management attempts to link inputs with outputs as well as with outcomes and impacts. The results of an organisational performance assessment provides learning lessons to

results-based management (Peterson, Gijsbers and Wilks 2003). Results-based management is an improvement over conventional compliance evaluation in assessing the effectiveness of project/programme activities, but it does not provide a satisfactory methodology for identifying and observing outcomes in policy processes (Pestieau 2003). In other words, the results-based monitoring and evaluation framework emphasises direct use of results in operational decisionmaking than indirect use in policy processes, and is prone to attribution error.

In a nutshell, various paradigms of performance assessment focus on various points of the results chain with apparent disagreements with each other. However, it is clear from the literature that with increasing aspirations to succeed through participatory and collaborative development interventions, impact assessment is increasingly seen as a tool for institutional learning and change (Franzel et al. 2008; Lilja and Dixon 2008). But this is not happening with influential bilateral and multilateral agencies. For example, in the Consultative Group of International Agricultural Research (CGIAR), impact assessments and other form of evaluations are geared primarily at providing information for fund-raising and satisfying donor accountability requirements (EIARD 2003), but institutional learning lessons are rarely internalised although they are often principally considered desirable (Hall et al. 2003; Watts et al. 2008). As far as learning lessons and behavioural changes are concerned, performance assessments approaches require the consideration of behavioural, cognitive and constructivist perceptions in learning and innovation (Hambly Odame 2008).

3. TECHNOLOGICAL AND SOCIAL INNOVATION ASSESSMENT

Innovation assessment, whether it is technological innovation or non-technological innovation, is an important process of managing change in organisations, networks and systems. This section reviews how technological innovation assessment is usually done and whether this paradigm of assessment has influenced the approaches of social innovation assessment — the non-technological aspects of research and development interventions.

Technological Innovation Assessment

When we broaden the definition of innovation to include social and organisational innovation, the innovation indictors should also include subjective assessment of learning and innovation. Although substantial work has been done to assess technological innovation (OECD 1992; OECD 2002), assessing non-technological innovation is a recent practice. For example, the European Innovation Scoreboard (ESI) is a good example of innovation indicators in practice, but most of the indicators are only suitable to assess technological innovations. The ESI includes various indicators assigned into input indicators, such as science and engineering graduates, public funding for innovation, and early-stage venture capital, and output indicators, such as employment in high-tech services, export of high-tech products, sales of new-to-firm and new-to-market products, and intellectual property rights registrations (Fletcher 2003; ISI 2006). Specifically in high technology industries, such as biotechnology, counting of products and processes new-to-firm and new-to-market has been used (van Moorsel, Carnfield and Sparling 2005).

The paradigm of technological innovation assessment also influences non-technological innovation assessment, as illustrated by Everett Rogers' (2003) classical analysis of the diffusion and adoption of hybrid maize in the United States. This study reported an S-shaped innovation diffusion curve representing the number of farmers adopting hybrid seed over time. The diffusion of innovation first increases at an increasing rate, then

increases at a decreasing rate and finally decreases at an increasing rate. Adoption is a bell-shaped probability function, with a small number of early adopters and laggards falling at two tails. In this study, adoption is an individual process and diffusion is a social process involving interaction between early adopters and late adopters. In this case the innovation was hybrid maize and counting the number of adopters over time resulted in influential results for managing change in agricultural production. Further studies in this area focused on the number and times of innovation adoption — often, but not necessarily limiting the assessment process for technological innovations (Damanpour and Schneider 2006; Subramanian and Nilakanta 1996). Attempts were also made to assess technical innovations, such as deposit share and return on assets, and administrative procedures in fields as distant as the banking industry and administrative reform.

Social Innovation Assessment

Since most innovation assessment processes focus on counting technological innovations, this tradition is also common in assessing social innovations. However, there is another body of literature that introduces a different approach to assessing innovation. This is not counting innovations *per se*, but assessing the organisational environment for creativity because the creativity climate is the root of all innovations (Amabile 1996; Amabile et al. 1996; Amabile and Gryskiewicz 1989; Ekvall and Ryhammar 1999; Kwasniewska and Necka 2004; Mostafa 2005). In this process of innovation assessment, factors that help or hinder creativity in organisations are determined either from theory, practice or both, and respondents are asked to provide their perception on the organisational environment using a Likert Scale.

Organisational performance depends on the interaction of resources they have, processes they involve and values — the criteria employees use when prioritising decisions (Christensen, Anthony and Roth 2004; Christensen and Raynor 2003). While the performance of novice organisations depends essentially on their resources, the performance of a more consolidated organisation depends increasingly on processes and

values, and less on resources alone. Organisations that are capable of managing change through individual and social learning within an organisation and across the system survive in changing environments (Christensen and Raynor 2003). Motivation to learn in and adapt to changing environments results from both market opportunities as well as non-market institutional arrangements. The latter category of motivations include a range of policies — educational opportunity, infrastructure development, tax and financial policies, policies to foster competition and collaboration among multiple stakeholders — that come under innovation policies.

4. SOCIAL INNOVATION ASSESSMENT: A TWO STAGE PROCESS

A two stage process of social innovation assessment methodology has been developed and implemented among stakeholders of DFID's 11-year RNRRS programme in plant science and crop post-harvest.

Design of the assessment tool

The first stage of the innovation assessment involved case studies of social innovations in DFID's Plant Science Programme in Nepal and the Crop Post-Harvest Programme in India. The data collection procedure involved semi-structured interview with key informants, focus group interview with farmers' groups, and direct observation of habits and practices of relevant stakeholders, document analyses. A Venn diagram-based tripartite actor map illustrating the public, non-profit private and for-profit private sectors with the rural communities and the informal sector at the centre served as a visual aid to initiate discussion during the interviews (Pant and Hambly Odame 2006).

In the second stage, a structured questionnaire was drafted based on the findings of the case studies. The SIA tool thus developed included questions about background of respondents and their organisations, work environment for learning and innovations, and modes of stakeholder interaction. A list of critical incidents that helped or hinder learning and innovations were generated from the analysis of the case study reports. The critical incidents reported by the key informants and focus group interview participants were triangulated against the information from direct observation and document analyses. Based on this information, the researcher prepared a list of statements about organisational environment for learning and innovations to be ranked by respondents along a four-point Likert Scale, 1 = 'statement never applies', 2 = 'seldom applies', 3 = 'often applies', and 4 = 'very often applies' to the respondents' current work environments (Box 1). Similar scales were also developed for modes of stakeholder interaction. Although this approach is based on social psychology of assessing work

environment for creativity, creativity as new ways of thinking (Amabile et al. 1996; Ekvall and Ryhammar 1999), this research focuses on the organisational environment for learning and innovations, innovation as new ways of doing things. The work environment for learning and innovation includes restrictive as well as supportive attitudes, habits and practices of stakeholders (Hall, Mytelka and Oyeyinka 2006; World Bank 2006).

Box 1. Sample questions on the Social Innovation Assessment Tool

How often the following statements apply to your current work environments? Please check an appropriate point on the scale.

1 = Never ever, 2 = Seldom, 3 = Often, 4 = Very often

		1	2	3	4
1	People in our organisation generally know what we are trying to achieve	○	○	○	○
2	People in our organisation believe that the usual way of doing things is the right way	○	○	○	○

As a part of your current work assignments, how often you practice the following modes of interactions with other formal sector organisations? Please check an appropriate point on the scale.

1 = Never ever, 2 = Seldom, 3 = Often, 4 = Very often

		1	2	3	4
1.	Interaction as a member of a committee, board, etc	○	○	○	○
2.	Interaction through joint publications/reports	○	○	○	○

As a part of your current work assignments, how often you practice the following modes of interactions with rural communities (farmers' informal groups, community groups, individual farmers)?

1 = Never ever, 2 = Seldom, 3 = Often, 4 = Very often

		1	2	3	4
1.	Interaction as a member of a committee or board	○	○	○	○
2.	Interaction through joint publications/reports	○	○	○	○

Implementation of the Assessment Tool

The SIA tool thus designed was pre-tested and administered with scientific staff from twenty-four organisations that were directly or indirectly linked to the DFID-supported projects in Nepal and India. Altogether 11 organisations in Nepal and 13 organisations in India were purposively selected for the survey. The organisations include agricultural research institutes, research and development organisations from the public and non-profit sectors, agricultural extension offices, agricultural universities and farmers' organisations. The respondents indicated that the main mandate of their organisations were research, teaching, extension and social mobilisation, and entrepreneurship. None of them identified policymaking as part of their main mandate. However, the scientific staff from the public sector organisations mentioned this function as their second or third mandate.

Since these organisations were mutually exclusive, stratified random sampling with proportionate allocation within an organisation was employed to select respondents from their respective organisations. Stratification could also be done with the mandate of the organisation, but the researcher did not determine the organisational mandate *a priori*. It was relevant to see how respondents identified their mandates. A list of scientific staff currently working in the organisations was acquired from the official records of respective organisations. The aggregate sample size was 165, which is 30 per cent of the total scientific staff in 23 organisations (Table 1). Although the SIA tool was originally intended for administration in an interview mode, the research followed a mixed approach to comply with the organisational culture and tight schedule of the scientists. Unless respondents specifically asked to self-administer the questionnaire, interviews were conducted. The higher their level of education, the greater the odds of respondents preferring to self-administer the questionnaire. Likewise, those in an authority position preferred to self-administer the questionnaire. In the latter case, the respondents and researcher worked through the completed questionnaire, mostly initiated by the respondents, to check that things went well.

Table 1. Demographic and Organisational Characteristics of the Respondents

Variable	N = 165	%
Worked in collaborative projects over the last 10 years		
Yes	113	68.48
No	52	31.52
Involvement in collaborative projects over the last 10 years (no. of years)[a]		3.67±3.55
Need to interact with for-profit private sector		
Yes	61	36.97
No	104	63.03
Need to interact with rural traders		
Yes	51	30.91
No	114	69.09
Country		
India	80	48.48
Nepal	85	51.52
Gender		
Male	143	86.67
Female	22	13.33
Age group		
Early-career 16-35 years)	42	25.45
Mid-career (36-55 years)	98	59.39
Late-career (56-75 years)	25	15.16
Highest level of education		
High school graduate	32	19.40
First university degree	40	24.24
Second university degree	44	26.67
PhD	49	29.70
Discipline		
Natural science	112	67.88
Social science	24	14.55
Interdisciplinary	16	09.70
Other (high school graduate, vocational training, etc.)	13	07.88
Place of training		
Locally	136	82.42
In other South Asian countries	16	09.70
Abroad from South Asia	13	07.88
Tenure in the current organisation (no. of years)[a]		14.16±10.55
Position in the organisation		
Decision maker	45	27.27
Decision taker	120	72.73

Variable	N = 165	%
Age of the respondents' organisation		
1-10	11	06.67
11-20	29	17.58
21-30	16	09.70
31-40	52	31.52
>40	57	33.55
Size of the respondents organisation[b]		
Small (•25 scientific/professional staffs)	15	09.09
Medium (25-50 scientific/professional staffs)	58	35.15
Large (>50 scientific/professional staffs)	92	55.76
Type of organisation		
Public	126	76.36
Non-profit private	39	23.64
Main mandate of the organisation		
Research	85	51.52
Teaching	24	14.55
Extension	41	24.85
Entrepreneurship	15	09.09

Notes:

[a]Mean±SD

[b]The size of the organisation, based on the number of professional staff, is adjusted for organisational structure — for organisations that were vertically integrated with a line of command from the centre, the small category is elevated to medium and medium is elevated to large.

Analysis of the Innovation Social Innovation Assessment Data

Depending on the level of sophistication desired and the statistical competence of the evaluators, the data generated through social innovation assessment can be analysed using a mix of qualitative and quantitative techniques (Table 2). Data from the case studies were manually coded and analysed through the construction of matrices and categories. When the volume of qualitative data gets thicker, evaluators can use appropriate qualitative data analysis software. Similarly, evaluators can choose quantitative data analysis technique at different levels of statistical competence and appetitive for quantifying results. Beginners can complete their analysis presenting the results in the form of summary statistics, such as mean, median, mode and standard deviation. Intermediate practitioners of statistical methods can try multiple regressions, factor analysis, and some other more sophisticated multivariate data analysis techniques. Since most multivariate techniques do not allow for the analysis of feedback effects that

commonly occur in complex adaptive systems, this limitation can be addressed using structural modelling (SEM), which provides an opportunity to assess feedback effects (Hair et al. 2006).

Table 2. Available Analytical Techniques for Social Innovation Assessment

Data source	Nature of data	Analytical methods	Available software
Case study/critical incident technique	Qualitative	Matrices and categories	NVivo
Innovation survey	Quantitative	(a) Summary statistics	Any statistical software, such as STATA, SPSS, SAS
		(b) Multiple Regression	
		(c) Factor Analysis, Multivariate Analysis of Variance (MANOVA), Multivariate Analysis of Covariance (MACOVA)	
		(d) Structural Equation Modelling (SEM)	AMOS, LISREL

The quantitative analysis of this study involves a multivariate analysis, employing factor analysis and multivariate regression using factor loadings as dependent variables. Since the objective of the data analysis was to find a latent construct of the work environments that enable learning and innovation, common factor analysis (CFA) was preferred over principal component analysis (PCA) because the latter's purpose is data reduction *rather* than pattern search (Hair et al. 2006). In other words, the former technique extracts factors based on shared or common variance while the latter is based on total factors (common variance, unique variance and error variance) (Spicer 2005). Once a pattern of the work environments for learning and innovation was determined, demographic characteristics of the respondents that influence the pattern were assessed using a specific type of multivariate regression analysis called seemingly unrelated regression.

Identifying Latent Construct of Work Environments for Innovation

Fifteen *items* about the work environments for learning and innovation were subjected to common factor analysis. The 15 X 15 correlation matrix gives determinant $|R| = 0.001$. This indicates that there is at least one linear dependency in the matrix and the items are factorable because the desirable value of the determinant is $0 < |R| > 1$. If $|R| = 1.0$, the correlation matrix is an identity matrix, meaning a matrix having 1's on the diagonal and 0's on the off-diagonal, and the items would not be suitable for factoring. Similarly if the absolute value of the determinant is zero, meaning the items are too highly correlated, then this often distorts the integrity of the results (Pett, Lacky and Sullivan 2003).

Another measure of the matrix *structure* is Bartlett's test of sphericity (Hair et al. 2006; Pett, Lacky and Sullivan 2003). The Bartlett's test gives calculated $\chi^2 = 1127.155$ with d.f. = 15 (14-1)/2 = 105. Since the p-value = 0, we reject the null hypothesis that the correlation matrix is not an identity matrix in favour of the alternative hypothesis, that there are relationships among the items. As with the determinant test, this test also indicates that the matrix is factorable.

Sampling *adequacy* for factor analysis can be assessed in absolute as well as relative terms. In absolute terms, it is unwise to attempt factor analysis if the sample size is less than 50 and a sample of 100 or more is preferable (Hair et al. 2006). In relative terms, it is suggested that the sample size should range anywhere from 2 to 20 respondents per variable (Stevens 2002). Both relative and absolute criteria indicate that the sample size of 165 is adequate. Moreover, the Kaiser-Meyer-Olkin (KMO) Test for sampling adequacy gives a value of 0.919, which is more than the minimum acceptable value of 0.50 (Hair et al. 2006; Pett, Lacky and Sullivan 2003).

Using CFA, a three factor solution was extracted (Table 3). The number of *factors* was determined based on the observation of the scree plot, which closely resembles the RPV (resources, processes and values) theory of innovation performance (Christensen et al. 2006). The Eigenvalue greater than one criteria, also called latent root criteria and which

determines the number of factors, was not appropriate here because it is most suitable for PCA.

Table 3. Factor Loadings of the Perceived Environments for Learning and Innovation

Items	Common factors			Unique-ness
	1	2	3	
Factor 1: Environments to share new unproven ideas				
We involve relevant stakeholders in our activities and address their needs	**0.875**	-0.127	0.065	0.301
We regularly monitor our relationships with other stakeholders	**0.745**	0.083	-0.042	0.398
People in our organisation have maintained a good network of stakeholders	**0.682**	0.277	-0.077	0.291
In our organisation, an individual is judged by how they interact with diverse stakeholders	**0.399**	0.267	0.156	0.469
In our organisation, conflict is a way of life in order to come up with new ideas	**0.322**	-0.004	0.230	0.752
Factor 2: Environments to maintain stakeholder values				
Individuals are generally proud of working in this organisation	0.013	**0.747**	0.019	0.410
In our organisation, good work is always recognised	0.123	**0.609**	0.083	0.429
We have enough time to reflect on our own successes and failures	-0.057	**0.602**	0.076	0.621
We usually have enough resources to invest in new ideas and experiments	-0.069	**0.565**	0.038	0.703
In our organisation we maintain a lively and active flow of information and ideas	0.184	**0.559**	0.019	0.497
We challenge one another's ideas in a constructive way	0.148	**0.464**	0.077	0.603
We have enough discretionary power with strong support from those in authority	0.271	**0.394**	-0.045	0.664
Factor 3: Environments to generate new ideas for actions				
People in our organisation are concerned about putting ideas into action	-0.048	0.026	**0.785**	0.403
People in our organisation are open to new ideas.	0.036	0.049	**0.734**	0.376
People in our organisation feel safe to express unusual ideas	0.153	0.104	**0.418**	0.632
No. of items in respective factors	5	7	3	
Mean±SD	2.75± 0.73	2.83±0.63	2.97 ± 0.70	
Cronbach's α	0.84	0.84	0.76	
Variance explained by the factor (%)	88.76	8.40	7.60	
Extraction Method: Common Factor Analysis Rotation Method: Promax Rotation (3.0) Overall Cronbach's α = 0.91				

The three underlying factors that determined perceived enabling environments for learning and innovation are labeled as follows: (1) *environments to share new unproven ideas*, (2) *environments to maintain stakeholder values*, (3) *environments to generate new ideas for actions*. These are based on the factors with highest loadings on respective factors. Two items in the Factor One and one item in the Factor Two have marginal but acceptable level of loadings because when the sample size is more than 100, the absolute value of loadings 0.30 to 0.40 is the minimum level for interpretation of factor structure (Hair et al. 2006). All other loadings suggest practically defined structures. These factors are interdependent because the extracted factors were subjected to an oblique *rotation*. The mean of the four-point scale (1 = 'never applies to one's current work environments', 2 = 'seldom applies', 3 = 'often applies', and 4 = 'very often applies) indicates that the average number of respondents perceived that the extracted factors less than often applies to their current work environments. However, their work environments for innovation are relatively more favourable in terms of generating new ideas for actions, followed by maintaining stakeholder values and sharing new unproven ideas.

The overall reliability of the items included in the three factor solution is high with Cronbach's $\alpha = 0.9108$ because the measure of reliability ranges from 0 to 1, with values of 0.60 to 0.70 deemed the lower limit of acceptability (Hair et al. 2006). Cronbach's α for the individual factors also indicate acceptable reliability of the factors. Moreover, *communalities* (1- uniqueness) were all above 0.3 except for one item in the Factor One, confirming that each item shared some variance with other items in a given factor.

Finally, the factor analysis indicates that resources are very much integrated with stakeholder values. Organisations with a good reputation have relatively more leverage over accessing *various* types of resources compared to organisations with underdeveloped values and missions. The following section investigates the factors that influence the underlying factors of learning, creativity and innovation.

Factors affecting perceived work environments for learning and innovation

Since an assessment of social and organisational environments for learning and innovation in the context of renewable natural resources, agriculture and rural development in low-income countries is lacking, a set of hypotheses about the variables, specifically related to stakeholder interaction, are proposed based on the empirical evidence from the qualitative case studies. However, studies in developed countries, mostly from the for-profit private sector organisations, suggest that stakeholder interaction positively influence environments for learning and innovation (van Moorsel, Cranfield and Sparling 2007).

Hypothesis 1: Stakeholders who work in partnership projects perceive their work environments more enabling for learning and innovation than those who does not work in such projects.

This hypothesis was accepted for all three factors of work environments for learning and innovation (Table 4). In other words, compared to those who did not participate in collaborative projects over the last decade, project participants perceived their work environments more favourable for learning and innovation in terms of all three factors — sharing new unproven ideas and maintaining stakeholder values and generating new ideas for actions. The perception of project participants about their work environments for sharing new unproven ideas was significantly higher than non-participants at 10 per cent level of significance, and the perception of work environments for maintaining stakeholder values, and generating new ideas for actions are significant at one and five percent levels of significance, respectively.

Hypothesis 2: Stakeholders who are required to interact with the for-profit private sector perceive their work environments more enabling for learning and innovation than those who are not required to do so.

This hypothesis was accepted for the first factor and rejected for the second and third factors. In other words, stakeholders who required interacting with the for-profit private

sector perceived their work environments more favourable for learning and innovation in terms of sharing new ideas compared to those who are not required to do so. However, in terms of maintaining stakeholder values and generating ideas for actions, both groups perceived their work environments in the same way. In this research, the for-profit private sector to which the respondents referred included local input suppliers, seed and sapling entrepreneurs, produce buyers and processors, and fertiliser and pesticide dealers.

Hypothesis 3: Stakeholders who are required to interact with rural traders perceive their work environments more enabling for learning and innovation than those who are not require to do so.

This hypothesis was rejected for the first two factors and accepted for the third factor. Respondents who are required to interact with the rural traders and those who are not perceived their work environments for innovation in the same way in terms of sharing new unproven ideas and maintaining stakeholder values. However, in terms of generating new ideas for actions, those who were required to interact with rural traders perceived their work environments more enabling for innovation than those who were not. The difference is significant at the five percent level of significance.

Table 4. Seemingly Unrelated Regression Coefficients for the Three Underlying Factors of Work Environments for Learning and Innovation

Variables	Share ideas	Maintain values	Generate ideas
Independent variables			
Worked in collaborative projects over the last 10 years (1= yes, 0= no)	0.188* (0.107)	0.307*** (0.104)	0.279** (0.115)
Need to interact with for-profit private sector organisations (1= yes, 0= otherwise)	0.181* (0.100)	0.022 (0.097)	-0.005 (0.107)
Need to interact with rural traders (1= yes, 0= no)	-0.139 (0.107)	-0.020 (0.103)	0.290** (0.114)
Control variables			
Tenure in the current organisation (years)	0.000 (0.006)	0.004 (0.006)	0.016*** (0.006)
Country (1 = India, 0 = Nepal)	0.267* (0.164)	0.535*** (0.159)	0.152 (0.175)
Sex (1 = male, 0 = female)	0.089 (0.134)	-0.045 (0.130)	-0.102 (0.143)
Age of the respondent 1 (1 = early-career 16-35 years, 0 = otherwise)	0.059 (0.196)	0.174 (0.190)	0.005 (0.210)
Age of the respondent 2 (1 = mid-career 36-55 years, 0 = otherwise)	0.209 (0.151)	0.156 (0.146)	0.040 (0.162)
Highest level of education 1 (1 = first university degree, 0 = otherwise)	0.211 (0.291)	0.314 (0.283)	0.262 (0.312)
Highest level of education 2 (1 = second university degree, 0 = otherwise)	0.064 (0.291)	0.183 (0.282)	0.049 (0.312)
Highest level of education 3 (1 = PhD, 0 = otherwise)	-0.073 (0.306)	-0.127 (0.297)	0.001 (0.328)
Discipline 1 (1 = social science, 0 = otherwise)	0.001 (0.143)	0.050 (0.138)	-0.085 (0.153)
Discipline 2 (1 = interdisciplinary, 0 = otherwise)	0.527** (0.233)	0.501** (0.226)	0.256 (0.250)
Discipline 3 (1 = others, such as vocational training, 0 = otherwise)	0.681** (0.312)	0.565* (0.303)	0.467 (0.335)
Place of training 1 (1 = South Asian countries other than their own, 0 = otherwise)	-0.063 (0.183)	0.030 (0.177)	0.149 (0.196)
Place of training 2 (1 = abroad from South Asia, 0 = otherwise)	0.087 (0.200)	0.085 (0.194)	0.134 (0.214)
Position in the organisation (1 = decision taker, 0 = otherwise)	-0.209* (0.108)	-0.048 (0.105)	0.071 (0.116)
Age of the respondents' organisation 1 (1 = 11 to 20 years, 0 = otherwise)	0.130 (0.468)	-0.090 (0.454)	1.439*** (0.501)
Age of the respondents' organisation 2 (1 = 21 to 30 years, 0 = otherwise)	- 0.171 (0.752)	-0.3489 (0.730)	1.467* (0.806)
Age of the respondents' organisation 3 (1 = 31 to 40 years, 0 = otherwise)	-0.161 (0.754)	-0.244 (0.731)	0.2789 (0.807)
Age of the respondents' organisation 4 (1 = > 40 years, 0 = otherwise)	-0.027 (0.776)	-0.280 (0.752)	0.895 (0.830)
Size of the respondents' organisation (1 = medium, 25-50 professional staffs, 0 = otherwise)	-0.800*** (0.317)	-0.530* (0.308)	-1.351***(0.340)
Size of the respondents' organisation (1 = large >50 professional staffs, 0 = otherwise)	-0.931*** (0.319)	-0.759** (0.309)	-1.071*** (0.342)
Type of the respondents' organisation (1 = non-profit private, 0 = public)	0.420 (0.573)	-0.113 (0.556)	-0.250 (0.614)
Mandate of the organisation 1 (1 = teaching, 0 = otherwise)	-0.193 (0.245)	- 0.166 (0.238)	0.122 (0.263)
Mandate of the organisation 2 (1 = extension, 0 = otherwise0	0.422*** (0.154)	0.152 (0.150)	0.291* (0.166)
Mandate of the organisation 3 (1= entrepreneurship, 0 = otherwise)	-0.648* (0.346)	- 0.551* (0.336)	0.638* (0.371)
Constant	2.948*** (0.740)	2.872*** (0.718)	2.296*** (0.793)
R^2	0.491	0.356	0.371
Test of overall fit of the model, χ^2 (27)	159.12***	91.29***	97.40***
Breusch-Pagan test of independence of residuals χ^2 (3) = 151.843***			
Estimator: Feasible Generalized Least Square (Iterated)			

Notes: *Significant at 10 per cent, **Significant at 5 per cent, and ***Significant at 1 per cent; Estimated standard errors are in parentheses.

In the regression model, the control variables are demographic as well as organisational. The longer an individual's tenure in an organisation, the better is their perception about the work environments for innovation in terms of generating new ideas for actions. When their tenure is a year longer it enhances their perception by 0.015 units (p-value <1). However, the tenure period did not influence respondents' perception about work environments for innovation in terms of sharing new unproven ideas and maintaining stakeholder values.

Compared to managers, subordinates perceived that their work environments for innovation were less favourable in terms of sharing new unproven ideas. The difference is significant at a 10 per cent level. However, in terms of environments for maintaining stakeholder values and generating new ideas, the differences are insignificant. The age and sex of the respondents did not influence perception.

Similarly, the level of education and the place of training did not influence the perceived work environments for learning and innovation. However, the discipline of training had some influence. The difference in perception of natural and social scientists was not significant, but compared to natural scientists those with interdisciplinary training perceived their work environments for innovation more favourably, in terms of sharing new unproven ideas and maintaining stakeholder values. Both differences were positive and significant at the five per cent level. However, the difference in terms of generating new ideas for actions was insignificant. Similarly, compared to natural scientists, those with vocational training perceived their work environments for innovation more favourably in terms of sharing new unproven ideas and maintaining stakeholder values. The differences were positive and significant at five and 10 per cent levels, respectively. As in the case of interdisciplinary experts, the difference was insignificant in terms of generating new ideas for actions.

The age, size and mandate of the respondents' organisation also influenced their perception. Compared to those working in 1-10-year-old organisations, respondents in 11-20-year-old organisations perceive their work environments less favourably in terms

of generating new ideas for actions, but not in terms of sharing new ideas and maintaining stakeholder values. The difference is significant at the one per cent level. Similarly, those in the 21-30-year-old organisations perceived work environments for innovation more favourably than those in 1-10-year-old organisations in terms of generating ideas for actions. This difference is positive and significant at the 10 percent level. Those working in 1-10-year-old organisations and those in more than 30-year-old organisations perceived their work environments in the same way.

Compared to respondents working in small organisations, those working in medium and large organisations perceived work environments for innovation less favourably in terms of all three factors — sharing new unproven ideas, maintaining stakeholder values, and generating new ideas for actions. The coefficients for all three factors are negative and significant.

While individuals working in the public and non-profit private organisations perceive their work environments in the same way, there were some differences among those working in organisations with various mandates. Compared to respondents working in research organisations, those in extension agencies perceived their environments more favourably for innovation in terms of sharing new unproven ideas and generating new ones for actions, but not in terms of maintaining stakeholder values. The differences for these factors were positive and significant at the one per cent and 10 per cent significance levels, respectively. Compared to researchers, individuals in the enterprise domain perceived their work environments less favourably for innovation in terms of all three factors — sharing new unproven ideas, maintaining stakeholder values, and generating new ideas for actions.

The perceived work environments for innovation for generating new ideas for actions were not different among Indian and Nepalese stakeholders, but Indian respondents perceived their work environments more favourably than their Nepalese counterparts for innovation in terms of sharing new unproven ideas and maintaining stakeholder values.

The analysis in this section revealed that stakeholders who worked in collaboration perceived their work environments more favourably for learning and innovation in terms of all three factors. However, interaction with for-profit private sector stakeholders and rural traders did not have the same level of influence. Stakeholders who interact with the for-profit private sector perceived their work environments favourably for learning and innovation in terms of sharing new unproven ideas. Similarly, stakeholders who interact with rural traders perceived their work environments favourably for learning and innovation in terms of generating new ides for actions.

5. USE OF SOCIAL INNOVATION ASSESSMENT RESULTS IN OPERATIONAL DECISIONMAKING AND INNOVATION CAPACITY DEVELOPMENT

An effective use of assessment results depends on stakeholder capacity to use the information at the individual, group, organisational, network and systems levels (Horton et al. 2003; Morgan 1998; Morgan 2005; Peterson, Gijsbers and Wilks 2003). Stakeholder capacity is not just operational, but, more importantly, adaptive or strategic. The former involves the potential to perform day-to-day activities while the latter involves the socially constructed capacities needed for the organisation to learn and change in response to changing technological, economic, social and environmental circumstances, including climate change (Hall 2005; Horton et al. 2003; Morgan 2005). The innovation assessment of the two programmes — one reported as a highly successful 'best bet' and another as a dismal failure — revealed that those who engaged in DFID's programmes and projects and interacted with the for-profit sector organisations and rural communities perceived their work environment more favourably for learning and innovation than the non-participants. More interestingly, compared to stakeholders engaged in the successful programme, those in the dismal programme perceive their work environment more favourably for learning and innovation in terms of sharing new unproven ideas and maintaining stakeholder values. This finding could easily turn the dismal project into a successful one as far as continuous learning and innovation beyond the specific interventions is concerned.

Stakeholder capacity involves an ability to successfully harness and apply resources and skills at the individual, group, organisational, network and systems levels towards achieving organisational goals and satisfying stakeholder expectations (Horton et al. 2003). When individual and group capacities are widely shared among the organisation's members and become incorporated its culture, strategies, structure and management systems, and operating procedures, they become organisational capacities. Likewise, when organisational capacities are widely shared at networks and systems levels, they become systems capacity relevant for addressing long-term social goals such as economic

growth, social inclusion and environmental protection. The innovation assessment framework developed through this study specifically focuses on behavioural changes of individual actors — changes in knowledge, attitude, skills and actions — with respect to their immediate environment so that they can develop their collective capacity to adapt to evolving contexts. Since the programmes' outcomes would have impacts on systems capacity development only in the long-term, the innovation assessment tool is specifically intended for outcome assessment rather than impact assessment.

Therefore, the linear logic of impact assessment needs to be complemented by an innovation assessment under the realm of the innovation systems framework by providing research managers with critical lessons for institutional learning and behavioural change (Hall, Sulaiman and Bezkorowajnyj 2008b; Hall et al. 2003). Although impacts of most research and development interventions are not known in advance, it is recognised that the adaptive capacity of innovation networks has substantial influence on the likelihood of a success (Ekboir 2003). In other words, valuable information for research managers, development workers and entrepreneurs cannot be obtained from one-time measures of outcomes and impacts but from continuous monitoring of the processes that produce the outcomes and provide lessons to enhance strategic capacity of stakeholders. It can be argued that behavioural and cognitive learning can and must be supplemented by constructivist approaches to individual, organisational, social and systemic learning.

The two-stage process of innovation assessment embeds critical incident techniques into case study research methods, and provides a basis for quantitative data collection in seemingly qualitative phenomenon, such as social and behavioural changes. Thus impact assessors interested in social innovation can build on already available qualitative data collection techniques — such as innovation histories (Biggs 2008; Hovland 2007; Watts et al. 2008), appreciative inquiry (Biggs 2008; Guijt 2007; Hovland 2007; Ochieng 2007; Watts et al. 2008), and most significant change (Guijt 2007; Hovland 2007; Watts et al. 2008) — and document critical incidents for innovation before they decide to move into the use of qualitative methods to generate useful institutional learning lessons and

evidence on the changes in the behaviour of concerned stakeholders. Evaluators can use the two stage process of social innovation assessment in two major ways:

1) Comparing the innovation readiness of project stakeholders before and after the completion of the project
2) Comparing the change in behaviour of the stakeholders from the same organisation who are directly engaged in project interventions and who did not have a chance to be involved in the projects

Since this study was conducted only after the completion of DFID-supported project interventions, it was only possible to do comparisons of the second kind, which revealed that the project participants perceived work environments more favourably for learning and innovation than the non-participants. Such a change in perception about work environments is a kind of outcome that brings about behavioural changes among concerned stakeholders — change in knowledge, attitude, skills and action — so that positive impacts could happen in the long-term. This emphasises the contribution of concerned stakeholders to generate outcomes than striving to demonstrate contributions of specific actors and factors.

6. CONCLUSION

There are two distinct bodies of literature that come together and inform impact assessment and other evaluation techniques employing the framework of the innovation systems in renewable natural resources, agriculture and rural development. On the one hand, impact assessors in international development are opening the 'black box' of science to find alternatives approaches to impact assessment. This is increasingly geared towards generating institutional learning for research managers, development workers and entrepreneurs. On the other hand, the literature on social psychology of creativity and learning provides tools to assess the organisational environment for creativity, which can be adapted to international development interventions. The social innovation assessment tool developed in this paper is such an effort to bring these two bodies of literature together and address some of the challenges of impact assessment in complex adaptive systems, such as agricultural innovation systems, where multiple actors and factors contribute to long-term impacts of research and development interventions. The SIA procedure is more an approach than a structured tool because the design of the social innovation survey questionnaire at the second stage depends on the documentation of the critical incidents using case study research methods at the first stage. Another distinguishing feature of this process is to document incidents leading to successes as well as failures. Under the realm of participatory research and development, attributing impacts to a particular actor — such as an initiator of crop improvement projects — and to a particular intervention can become further challenging. In this case, moving from attribution to contribution of various factors and actors, and generating critical learning lessons to innovation generation are desirable.

The literature on international development performance assessment has already introduced alternative assessment techniques — such as outcome mapping, innovation histories, appreciative inquiry and most significant change — but professional evaluators also need to digest the literature on assessing the work environment for learning and innovation, specifically the critical incident technique. A cautionary note, however, is that the social innovation assessment process should move well beyond assessing

individual creativity and the organisational environment for creativity and address learning and innovations at network and systems levels. Further research on the role of individual change agents within an organisation, network or system is imperative as the latter can either facilitate or constraint the agency of individuals. This could be one area where institutional learning lessons from the monitoring and evaluation of international development interventions can contribute towards enhancing research and development impacts.

Notes

1. The partnership projects were limited to the public and civil society organisations, such as government agencies, universities, NGOs and farmers' organisations. The for-profit private sector actors, including rural traders, were not directly involved in the collaborative projects.
2. Unlike in industrial economies, the public-private collaboration involving the for-profit private sector is still emerging in Indian and Nepalese agriculture, specifically in the commodities considered for the case studies. Although the collaborative projects did not involve this sector directly, about 35 percent of respondents mentioned that they required interacting with the for-profit private sector as part of their regular activities.
3. About 30 percent of the respondents mentioned that they required interacting with rural traders. The case studies in India and Nepal revealed that rural traders are a strong group of stakeholders, but often operate informally. As in the case of the previous hypothesis, information on how this kind of interaction influences stakeholder perception about work environments for learning and innovation is lacking.
4. Adaptive capacity is also referred to as innovation capacity (Hall 2005) or deep capacity (Morgan 2005).

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